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The Impact of Capillary Ageing on In Silico Brains: A Stroke Comparison

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1. Introduction

Age is the most important non-modifiable risk factor predicting outcomes of stroke and its treatment. To develop successful in silico clinical trials of stroke treatment [1], virtual populations of ageing brains are important. Here, age is introduced as a parameter in the simulation of stroke to determine its impact on lesion size.

2. Materials and Methods

2.1 Healthy and Stroke Scenarios The full-brain perfusion and stroke simulations are developed using the INSIST framework [1]. The porous representation of the microvascular network is used for the simulations [2]. A right middle cerebral artery occlusion (RMCAo) is simulated with a non-porous clot (Fig 1a,b).

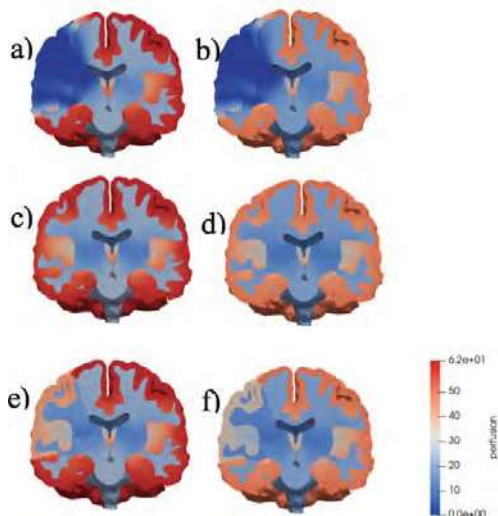


Figure 1: Perfusion maps of a) Middle aged (MA) RMCAo; b) Old RMCAo; c) MA micro-emboli; d) Old micro-emboli; e) MA pericytes; f) Old pericytes

2.2 Micro-emboli post-thrombectomy A micro-emboli shower is released after the clot is removed; the permeability and coupling coefficients of the microcirculation are updated using a previously published model [3].

2.4 Pericyte Contraction Assuming the stroke lasts long enough such that pericytes die and contract, we assume a 10% diameter reduction in capillaries in the focal region of the stroke (defined as < 30% of the original CBF).

2.5 Ageing Using a published model of capillary ageing, the permeability and coupling coefficients are updated to simulate ageing, using a 25% reduction in permeability and coupling coefficients [4].

3. Results

Simulations of the scenarios can be found in Fig 1. On average, older age brains have 20% less flow, yet the stroke lesion size was 10% larger in older brains (Table 1).

	Middle	Old	Old:Middle
Healthy (mL/min)	606	490	0.809
RMCAo (mL/min)	508	412	0.811
Micro-emboli			
(mL/min)	602	488	0.811
Pericytes (mL/min)	578	467	0.808
Stroke lesion volume (mL)	237	260	1.097

Table 1: Comparison of old and middle age for the different scenarios

4. Discussion

A model of the ageing capillary bed is implemented here in a full-brain stroke simulation, demonstrating the impact age has on CBF and stroke. Future work will extend ageing to the arterioles and large blood vessels such that in silico virtual populations of ageing brains are developed.

5. References

- [1] Konduri et al. *Fron. Neurology* 2020
- [2] Józsa et al. *Interface Focus* 2020
- [3] El-Bouri et al. *PLOS Comp. Biol.* 2021
- [4] Graff et al. *Fron. Ageing Neuroscience* 2022

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